



High Performance Laboratory Design

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Lawrence Berkeley National Laboratory





Workshop Tracks

Laboratories and Industrial Facilities

Session 2: 4:00 p.m. – 5:30 p.m.

High Performance Laboratory Design

Intent: To introduce high performance design of laboratories and distribute an electronic design guide to participants.

Description: Free software containing the Design Guide for Energy Efficient Labs will be distributed (bring your laptops). An overview of laboratory design issues and use of the Design Guide will be presented, followed by a facilitated discussion of hot topics (topics to be selected by attendees may include: HVAC, fume hoods, controls, commissioning, minimum air changes, and codes vs. standards). This session is for participants familiar with laboratory design issues.

Moderator: Dale Sartor, Lawrence Berkeley National Laboratory

Speaker: Geoffrey Bell, Lawrence Berkeley National Laboratory





Who is in Attendance?

- ✦ Building Owners
- ✦ University/Government Facility Operators
- ✦ Architects
- ✦ Engineers
- ✦ Designers
- ✦ Energy Managers
- ✦ and ?





Session Goals...

- ✦ **Overview:** Energy Design Process
- ✦ **Present:** Design Guide Tool
- ✦ **Discuss:** Hot Topics & Design Barriers
- ✦ **Summary**





The Energy-Efficient Design Process

- ◆ Minimize the Load
- ◆ Determine Potential Load Variability
- ◆ Match Variable Load with an Adjustable System
- ◆ Use an Integrated Energy Engineering Approach: Right Sizing
- ◆ Understand Barriers
- ◆ Promote Safety Relationship





Safety and Energy-Efficient Design

- ◆ Insurance Industry lists specific “Named Perils & Events” in laboratory spaces.
- ◆ These perils and events are linked to “Loss Prevention Measures” including:
 - ◆ Building Commissioning
 - ◆ Demand-Controlled Ventilation
 - ◆ Economizer Cooling
 - ◆ Efficient Duct Systems
 - ◆ Efficient Lighting
 - ◆ Energy Management and Control Systems
 - ◆ Heat Recovery Ventilation
- ◆ All “Measures” are covered in the Guide.





Safety and Energy-Efficiency Features

- ◆ Additional items in the Guide that specifically relate to safety and energy efficiency include:
 - ◆ fume hoods
 - ◆ biological safety cabinet selection
 - ◆ room pressurization schemes and techniques
 - ◆ filtration systems
 - ◆ glove boxes
 - ◆ variable air volume laboratories
 - ◆ laboratory utility locations and access
 - ◆ laboratory egress and adjacency
 - ◆ exhaust stack design and modeling (effluent dispersion)
 - ◆ system redundancy
 - ◆ modular plant design
 - ◆ right sizing





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LBNL Design Guide...

- ➔ focuses comprehensively on energy issues in highly specialized research laboratory and cleanroom environments.
- ➔ addresses many antiquated rules of thumb, which often inadvertently cause energy inefficiency.
- ➔ introduces energy decision-making into the earliest phases of the design process.
- ➔ provides access to literature on pertinent issues.
- ➔ helps designers become aware of debates and issues related to energy efficiency.
- ➔ fills an important void in the general literature and compliments existing in-depth technical manuals.

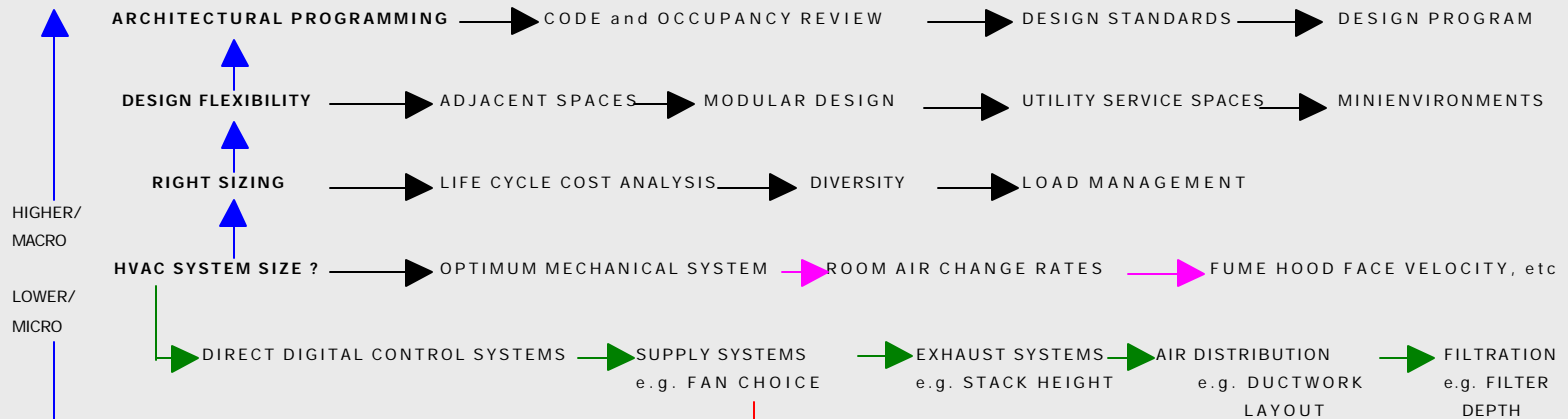




How to use the Guide

DESIGN GUIDE PHILOSOPHY AND DECISION-MAKING PROCESS

EXAMPLE DESIGN GUIDE PROCESS FLOW CHART



The final step in the design of the supply system is the choice of the fan. Careful attention to the brake horsepower required for the particular design condition is required. Included with the normal operating situation are; the part-load, start-up, and full bypass energy loads. For example consider a single-width, single-inlet, air-foil fan at 20,000 CFM @ 2.5" w.g.

SIZE (in.)	RPM	BHP
33	1200	15.6
36	960	13.8
40	767	12.3
44	653	12.1
49	586	12.6
54	524	13.8

Range of
Minimum
Horsepower





Chapter Levels - First Level

◆ Highest Level

- Provides an executive summary
- Identified with integer, e.g., 6.0 is the Chapter on Exhaust Systems.

◆ Abstract Form

- Presents main energy-efficiency points in chapter.

◆ General Overview of Chapter Topic

- Highlights and summarizes chapter's key topics.





Chapter Levels - Second Level

◆ Sub-Topic Level

- Presents significant sub-topics
- Identified with two numbers, e.g., 6.3 is the Section on Variable Volume Hoods.

◆ Techniques for Energy Efficient Design

- Provides more energy-efficiency specifics.

◆ For Architects, Planners, and Managers

- Furnishes decision-makers with key information.





Chapter Levels - Third Level

◆ System/Component Level

- Presents system design and component features.
- Identified with three numbers, e.g., 6.3.2 is the Section on Fume Hood Face Velocity Control.

◆ Energy-Efficient Design and Specification

- Provides analyses energy-efficient systems and components.

◆ For Engineers and Designers

- Furnishes “nuts and bolts” information.





Chapter Levels - Fourth Level

◆ Background/Case Study Level

- Presents very specific background and support information.
- Identified with four numbers, e.g., 6.3.2.4 is the Section on Fume Hood Face Velocity Response Time.

◆ Case Studies and Examples

- Provides information and articles on sizing and installations.

◆ Engineering and Design Basics

- Furnishes reader with background literature and information.





Design Guide Chapters

- **Chapter 1: Introduction**
- **Chapter 2: Architectural Programming**
- **Chapter 3: Right Sizing:
Choosing an Energy-Efficient Design**
- **Chapter 4: Direct Digital Control Systems**
- **Chapter 5: Supply Systems**
- **Chapter 6: Exhaust Systems**
- **Chapter 7: Distribution Systems**
- **Chapter 8: Filtration Systems**
- **Chapter 9: Lighting Systems**
- **Chapter 10: Commissioning**





1. Design Guide Introduction

◆ Scope

- For multiple audiences: building owners, planners, architects, and engineers, and energy utility personnel.

◆ Purpose

- “...to foster energy efficiency in research laboratories.”

◆ Application

- Research laboratory-type facilities in universities and in commercial and industrial facilities, that have laboratories and cleanrooms.

◆ How to Use the Guide

- Hierarchical format moving from macro to micro levels.
- Chapters are presented in four increasingly technical levels.





2. Architectural Programming





2. Architectural Programming

- ***2.1 Codes Vs. Standards***
- ***2.2 Design Program and Flexibility***
- ***2.3 Laboratory Adjacency and Utility Service Spaces***
- ***2.4 Modular Design and Minienvironments***





3. Right Sizing: Choosing an Energy-Efficient Design





3. Right Sizing: Choosing an Energy-Efficient Design

- ***3.1 Life-Cycle Cost Analysis***
- ***3.2 System Sizing***
- ***3.3. Diversity***
- ***3.4 Load Management***





4. Direct Digital Control (DDC)





4. Direct Digital Control (DDC)

- ***4.1 DDC Implementation***
- ***4.2 Sequence of Operation***
- ***4.3 Total Laboratory Energy Management (TLEM)***





5. Supply Systems





5. Supply Systems

- **5.1. *Plant Devices***
- **5.2. *Air Systems***
- **5.3. *Air Handling Units***
- **5.4. *Energy Recovery***





6. Exhaust Systems





6. Exhaust Systems

- **6.1. Overview**
- **6.2. Exhaust Devices**
- **6.3. Variable Volume Hoods**
- **6.4. Manifolded Exhaust**
- **6.5. Effluent Dispersion**
- **6.6. User Interface**





7. Distribution Systems





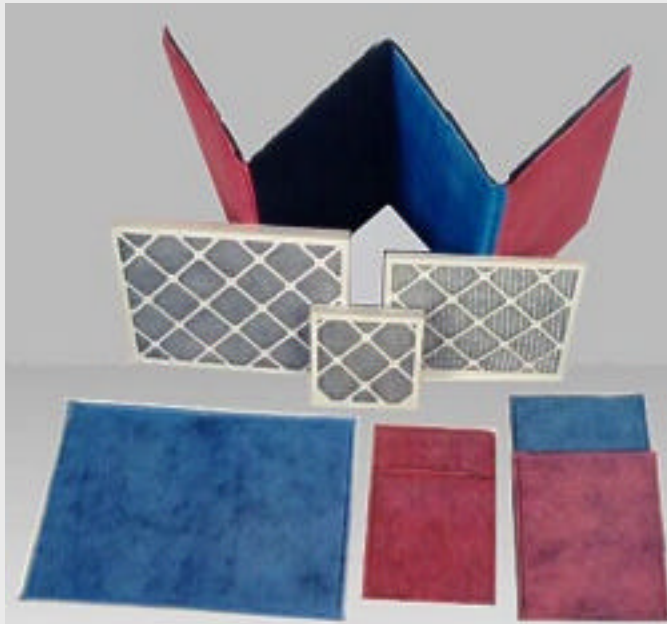
7. Distribution Systems

- ***7.1. Air Distribution***
- ***7.2. Room Pressure Control***
- ***7.3. Diffusers***
- ***7.4. Noise Attenuation***
- ***7.5. Pumping Systems***





8. Air Filtration





8. Air Filtration

- **8.1 *Degree of Filtration***
- **8.2. *Filter Pressure Drop***
- **8.3. *Electronic vs. Media Filtration***





9. Lighting





9. Lighting

- ***9.1 Lighting Design Considerations***
- ***9.2 High-Efficiency Lighting Components***
- ***9.3 Lighting Control***





10. Commissioning





10. Commissioning

- ***10.1 Introduction to Commissioning***
- ***10.2 Installation Verification***
- ***10.3 Operational Assessment***
- ***10.4 Performance Measurement***
- ***10.5 Efficiency Assurance***





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“Hot Topics”

- ➔ **Integrated System Design: Right-Sizing for Energy Efficiency**
- ➔ **Safety & Energy Efficiency Work Together**
- ➔ **Energy Monitoring and Control System with Direct Digital Control**
- ➔ **Fume Hood Options**
- ➔ **Air Flow Rates**
- ➔ **Modularized Plant Devices**
- ➔ **Heat Recovery**
- ➔ **Segregating Tasks with Minienvironments**
- ➔ **Indirect-Direct Evaporative Cooling**
- ➔ **Other Measures**





Barriers to Energy-Efficiency

- The Guide can help overcome perceived barriers to energy efficiency including:
 - **Standard Design Practices**
 - **First Cost over Life-Cycle Cost**
 - **Lack of Time: Project Due Yesterday**
 - **Energy-efficiency features “unproven”**
 - **Operation and Maintenance Costs not clearly understood**
 - **Some Codes and Architectural priorities limit design**
 - **Inadequate space in facility allotted**
 - **Performance envelope specification may limit options**
 - **Experienced Designers in short supply**





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Summary...

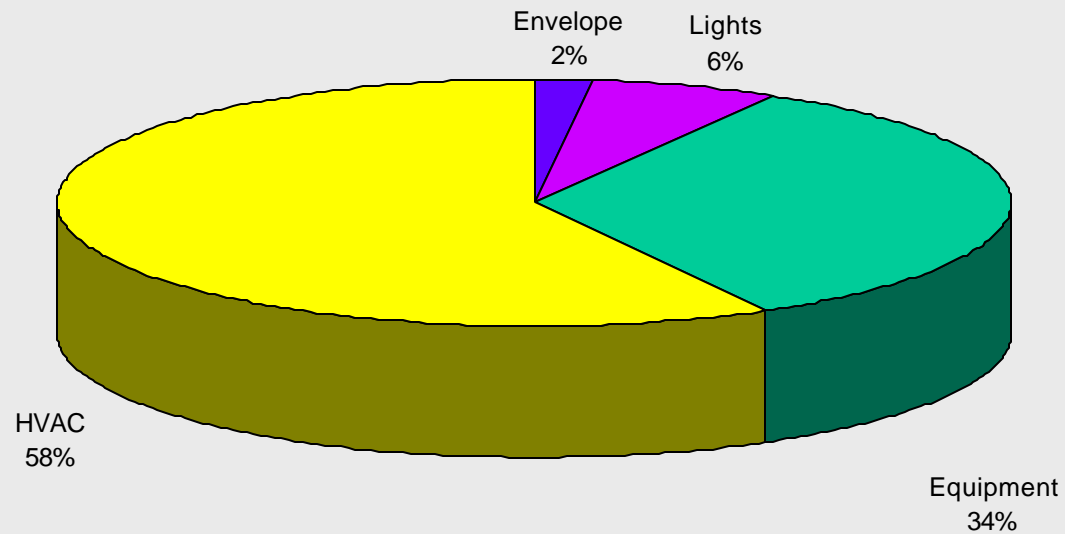
- ✓ Introduce energy efficiency early into a design process.
- ✓ Incorporate Integrated Energy Engineering, “Right Sizing”, techniques.
- ✓ Match Variable Load with an Adjustable System.
- ✓ Understand debates and issues related to energy efficiency.





Energy Use by a Laboratory

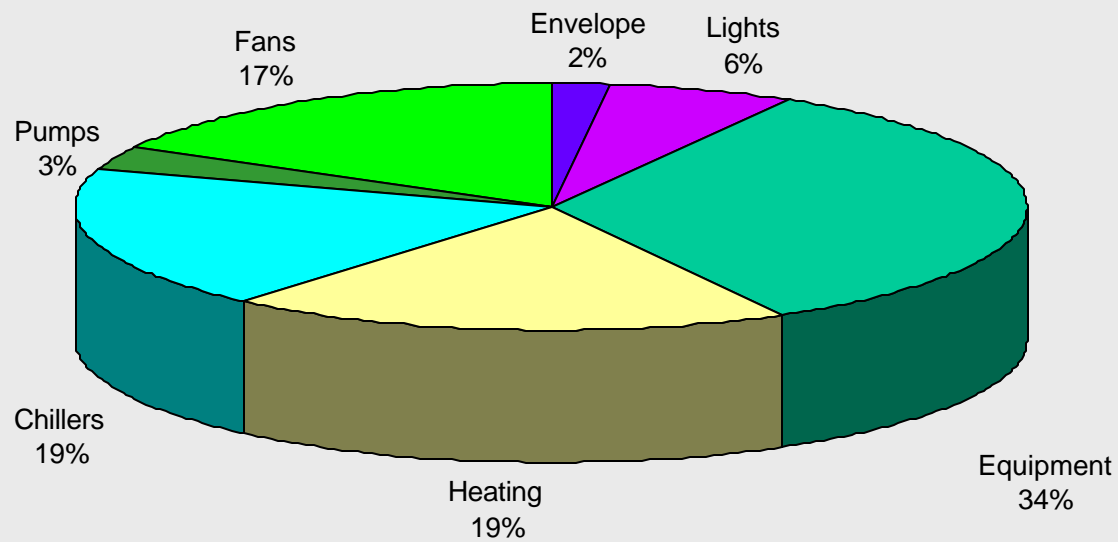
Laboratory Energy Pie





Energy Use by a Lab. - Detail

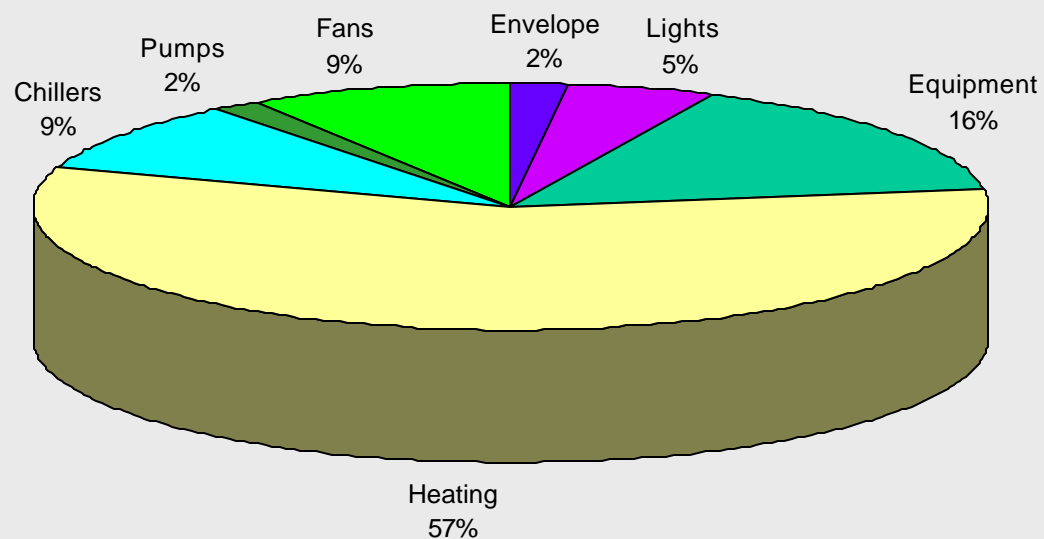
Laboratory Energy - Detail





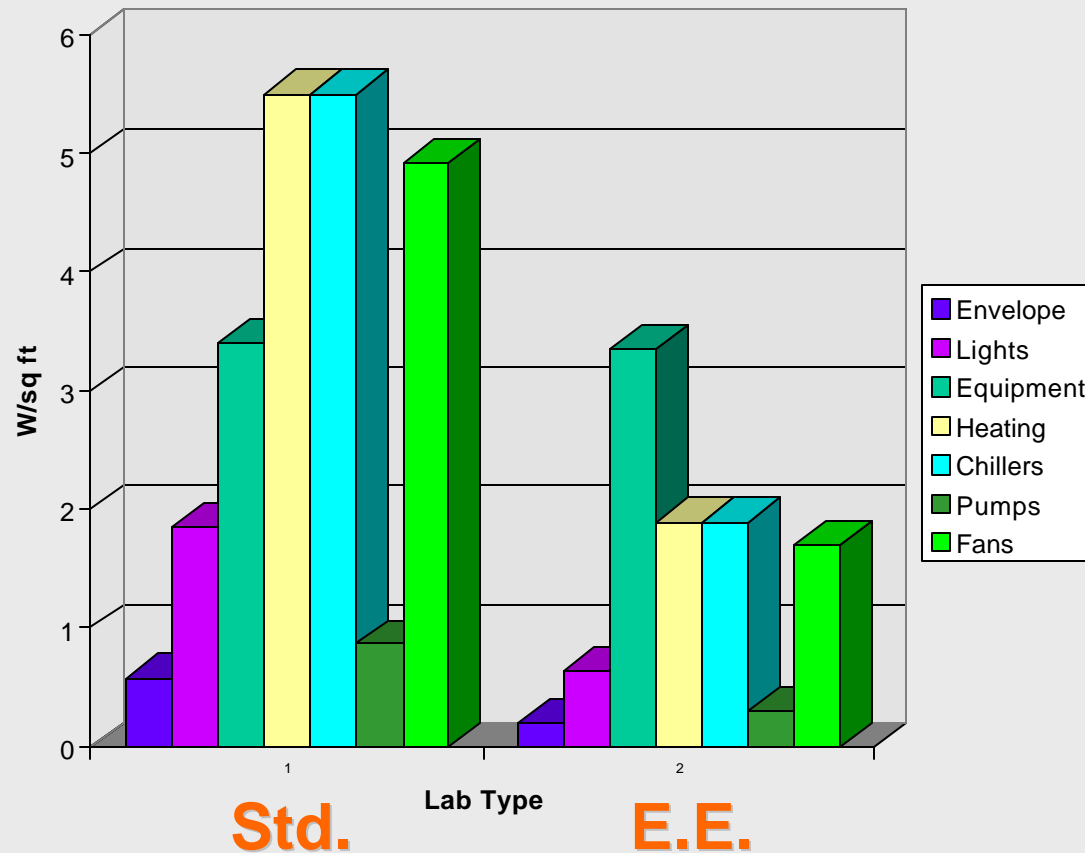
LBNL Lab Energy Use

LBNL Lab Average





Lab Energy Use: Std. vs. E.E.





Where to get more information

- ◆ New Tool Kit web site (under construction)
=> <http://Labs21.lbl.gov/>
- ◆ Lawrence Berkeley National Laboratory;
Applications Team web site
=> <http://ATeam.lbl.gov/>
- ◆ Lawrence Berkeley National Laboratory;
Environmental Energy Tech. Div.; web site
=> <http://eetd.lbl.gov/>





A-Team & Guide Web Site



**A Design Guide for
Energy-Efficient
Research Laboratories**

Please visit our web site for latest Guide information
and download the Windows™ HTML-Help file at:

<http://ateam.lbl.gov/design-guide>

